

Peace Engineering: A Partnered Approach to Engineering Education

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Abstract

Peace engineering is a new discipline that merges engineering with social and applied sciences and with peacebuilding for the dual purposes of integrating technical analysis and engineering into peacebuilding practice and also infusing conflict-sensitivity and peacebuilding skills into engineering design and practice. It builds on a partnered approach to curriculum development, research, community engagement and design. The Peace Engineering program at Drexel prepares engineers to work as better partners in complex situations like conflict zones, fragile nations or post-disaster regions, and to incorporate conflict sensitivity into their work. We offer an M.S. degree, a graduate certificate and undergraduate course offerings and co-op learning opportunities. Our goal is to prepare students both to promote diversity and incorporate traditional knowledge into existing engineering work, and also to engage in challenges and realms that may not necessarily fall within traditional engineering practice. In this paper we present our approach to building engineering curricula, engaging in community-partnered research, and reframing the engineering design process. We address challenges in creating intersectionality across disciplines and present examples of our coursework, partnered research projects and engaged outreach.

Motivation

Imagine what it would be like if all engineers, or all engineering work, supported environmental protection, social justice, human rights and peace. Of course some of it does. But some of it enforces norms and inequities that work against these ideals. So how do we pivot? How do we elevate these values within engineering education and the workplace, and what are new modes of engagement, research, development and design that will help us get there?

Building a Peace Engineering Curriculum

The Peace Engineering program at Drexel was developed in partnership with the U.S. Institute of Peace (USIP) and its technology-based spinoff PeaceTech Lab (PTL) with a vision to educate professionals capable of identifying challenges and implementing solutions at the intersection of peacebuilding and engineering. Our goal is not only to integrate STEM students and researchers into peacebuilding, but also to embed peacebuilding practices throughout traditional engineering sectors, thereby developing the integrative skills recommended by USIP, the National Academy of Engineering (NAE), and the conflict management community [1], [2], [3], [4].

The graduate program began enrolling students in 2019 and includes both an M.S. degree for students from all STEM backgrounds and a 9-credit online certificate accessible to students from all backgrounds. We present a peace engineering curriculum that offers breadth in understanding the social dimensions of conflict, depth in engineering approaches and technologies applicable to peacebuilding, and practical experience working alongside peacebuilding practitioners. A systems-level thinking approach is leveraged to equip engineers to think critically about contexts into which their solutions will be delivered and assess the human, social and security impacts of solutions being explored. Systems engineering provides a framework and method for

assimilating the multitude of interacting factors and dynamics in human, economic, social, natural and engineering systems into target design requirements. The plan of study for the M.S. degree was developed with input from over 30 faculty members from Drexel's College of Arts and Science, College of Computing and Informatics, College of Engineering, College of Media Arts and Design, School of Education, and School of Public Health and is detailed below:

1. *Core Peace Engineering Competencies* (12 credits) – Introduction to Peacebuilding for Engineers, Conflict Management for Engineers, Peacebuilding Skills, Peace Engineering Research Seminar.
2. *Core Engineering Competencies* (9 credits) –Systems Analysis for Peacebuilding, Risk Assessment, Introduction to Project Management
3. *Research Competencies* (9 credits) –Research Design and Qualitative Data Analysis, Data Based Engineering Modeling, Community Based Design
4. *Social Dimensions of Conflict* (6 credits) – To develop competence in fields pertinent to conflict, students will select two courses from approved offerings in Public Health, Politics, Science, Technology and Society, Communications, and Education.
5. *Technical Focus Areas* (6 credits) – To develop mastery in a technical field applicable to peacebuilding, students select a two-course sequence in one of the following tracks: Systems Analysis; Software Development; Machine Learning and AI; Information Security; Database Management; Information Retrieval; Data Mining; Web and Mobile Development; Game Design; Serious Gaming; Interactivity; Animation; Water, Sanitation and Hygiene; and Power Systems and Distribution.
6. *Experiential Learning* (6 credits) – civic engagement, field research with academic partner; or internship with external agency.

Core peace engineering courses are co-taught by engineering faculty and peacebuilding practitioners. These core courses include:

- *Introduction to Peacebuilding for Engineers*: Developed in partnership with peacebuilders from the PeaceTech Lab and USIP's Academy for International Conflict Management, this course introduces engineering students to the concepts and skills practiced in the field of international peacebuilding and conflict transformation. This course provides students with first-hand accounts of peacebuilders describing the challenges and opportunities in their work, short presentations outlining key theories and concepts that guide peacebuilding as a practice, and opportunities to think about how this knowledge, skills, and attitudes can be applied to real-life peacebuilding dilemmas.
- *Systems Analysis for Peacebuilding*: The course is intended to give an introduction to systems engineering and system dynamics and applies these tools in the context of peacebuilding. Topics include system architecting, systems mapping, causal loop diagrams, stock and flow diagrams, data sourcing, decision making and game theory. Examples of conflict are presented and various theories of change are tested using systems models.
- *Conflict Management for Engineers*: As the pace of science and technology innovation increases, so does the role of engineers in solving some of the world's toughest challenges. The prevention of violent conflict and the pursuit of a sustainable peace is just such a challenge. Developed in partnership with the PeaceTech Lab and USIP, this course introduces engineering students to the concepts and skills they will need to use their technology expertise in service of conflict-affected communities. The course provides

students with an introduction to the theory and practice of conflict analysis, strategic peacebuilding, and negotiation.

- *Peacebuilding Skills*: Peacebuilding Skills focuses on intercultural communication and facilitation in the context of peacebuilding. Cases drawn from historical peacebuilding and stabilization activities are used to provide a framework from which to understand how communication and facilitation affect the development of a conflict and the ability to resolve conflict without violence. Weekly online classes include a discussion of a subject's theory and a presentation of the impact of the theory in practice. The course relies on ongoing reflective analyses to help students link the theories and practices of effective peacebuilding to explorations of personal beliefs.

Community-Partnered Research and Outreach

We envision a reimagined framework for how universities engage in societally-relevant research and a new process for developing a cross-trained community of practice of individuals effective at community-partnered research. Our vision for growing partnered research involves engaging academic researchers from multiple disciplines with practitioners working in communities, fostering a professional identity that values convergence, and providing opportunities for researchers and students across disciplines to engage in societally relevant work. Peace Engineering researchers propose a new paradigm for societally relevant research that draws on expertise from both the social and the applied sciences and fundamentally alters both the timing and the depth of stakeholder engagement. Central to this process is creating shared language and techniques that enable partners with disparate expertise to discuss core principles, integrate systems analysis, establish shared data-driven monitoring and evaluation methodologies, and articulate best practices. Our aim is to create genuine interdisciplinarity, wherein “a number of separate disciplines surrender their own axiomatics and collectively define themselves by reference to a common strategic axiomatic” [5]. Peace Engineering research sits in the space where multiple disciplines, theories of practice, and collections of knowledge come together to build a new, hybrid discipline.

By immersing researchers in the contextual challenges faced by on-the-ground practitioners and communities, our intention is to co-generate practical research priorities with community partners, develop tools with immediate applications, and create resilient and responsive systems. We abandon the traditional model of university scholars defining research priorities, developing tools and solutions and then implementing them in society, and instead adopt a model of co-defining priorities with community partners and organizations, connecting diverse and inclusive teams to advance generative improvements, and building networks of adopters and implementers. Partnerships at Drexel that have led to research and outreach projects have originated both through personal connections and through deliberate networks and networking activities. For example, the Community & College Partners Program (C2P2) works to connect poor, underserved communities with technical assistance and resources that colleges and universities can provide [6]; Engineering for Change also connects underserved communities with technical specialists to advance ongoing projects [7]. Additionally, we have participated in a number of academic-practitioner workshops ([8], [9], [10]) in which the goal was to build a shared understanding of on-the-ground challenges, identify research needs in field practice, promote systematic research partnerships and identify potential technological tools that may be

employed effectively in different situations. Through these activities we have built partnerships that have grown into concrete research projects. It is important to note that the time-scale of these activities is often slower than that of traditional university research. This is due to a number of different factors, including challenges in coordinating schedules, the importance of building trust at its own speed, and the complexity of incorporating diverse knowledge, data and experiences in a meaningful way.

Reframing Engineering Design

Peace Engineering offers a framework for applying and adopting technology and engineering design for the sustained benefit of humanity. Much in the same way that life cycle assessment frameworks incorporate questions of how technology interacts with the environment and natural resources (e.g. what materials are used, how far they travel and at what energy cost, what happens to products at the end of their useful lives), a peace engineering design framework (Figure 1) considers how engineering and technology interacts with society, potentially contributing to or mitigating conflict. Applying a lens of conflict sensitivity to traditional engineering design and technology development introduces questions such as: Who defines what is needed? Who has access to this technology and who does not? How may it be used and/or misused? Where are the risks and benefits incurred and realized? What does this technology introduce to other communities and markets?

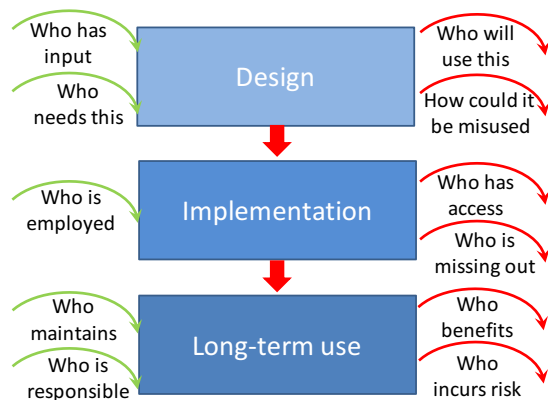


Figure 1. A framework for conflict-sensitive engineering design and technology development

It is our goal to adopt practices that incorporate cultural values, consider conflict dynamics and promote environmental sustainability in such a way that will guide engineering work to promote healthy and peaceful communities and societal change.

Summary

Within the existing landscape of global engineering, sustainable engineering, humanitarian engineering and development engineering programs, peace engineering was designed specifically to address the technological needs of peacebuilding practitioners. We embrace systems-level thinking to consider the technical, social and environmental impacts of engineering design and work to promote outcomes of peace, including environmental sustainability, cultural sensitivity and conflict mitigation.

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